INTERAGENCY COOPERATIVE LARGEMOUTH BASS MONITORING FOR TIDAL POTOMAC RIVER

EXECUTIVE SUMMARY

The largemouth bass fishery of tidal Potomac River is among the most popular in the Mid-Atlantic region and the United States. This fishery is managed by resource agencies from four jurisdictions that include Maryland, Virginia, District of Columbia, and Potomac River Fisheries Commission. Seeking a unified assessment of the fishery, these jurisdictions have developed a strategy to monitor the fishery and generate an assessment every 3 years. The objectives of the strategy are to estimate abundances for stock, quality, and preferred sizes of largemouth bass using a combination of mark-recapture and creel surveys. Such angler generated data will be used by the agencies to cooperatively monitor the population size of largemouth bass. The assessment will be provided to Potomac River Fisheries Commission and the general public according to the timeline specified herein.

This proposal was co-authored by agency staff forming the interagency cooperative.

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Introduction

The largemouth bass fishery of tidal Potomac River is among the most popular in the Mid-Atlantic region and the United States. This fishery is managed by resource agencies from four jurisdictions that include Maryland, Virginia, District of Columbia, and Potomac River Fisheries Commission. Seeking a unified assessment of the fishery, these jurisdictions have developed a strategy to monitor the fishery and to report an assessment to stakeholders every 3 years.

The goal of the cooperative management strategy is to jointly monitor the largemouth bass fishery in tidal freshwater of Potomac River by conducting surveys and reporting an assessment for the fishery. Every three years, a joint assessment report will convey results from these objectives to stakeholders.

The objectives of the cooperative management strategy are:

- Estimate abundance of stock size largemouth bass (≥ 200 mm total length) from tidal freshwater of Potomac River using a mark-recapture project and recreational creel data;
- Estimate abundance of quality (≥ 305 mm total length) and preferred size (≥ 381 mm total length) largemouth bass from tidal freshwater of the Potomac River using a mark-recapture project and tournament creel data.

Methods

Mark-Recapture

Tidally influenced freshwater habitats of Potomac River will be surveyed using boat electrofishing between mid-March to mid-April (Table 1). All largemouth bass that are equal to or greater than 200 millimeters in total length will be tagged near their dorsal fin and in their dorsal muscle using Floy Anchor tags (FD-94, 5/8" extra-long, orange color in 2020 and different colors thereafter). Largemouth bass will be measured, weighed, tagged, and released in the area of collection.

Sampling areas will be divided into quadrants and include areas where largemouth bass is known to occur (Fig. 1). Each quadrant is 1 km by 1 km and will be boat electrofished for 1200 seconds. Of the 184 possible quadrants, 60 will be randomly selected and surveyed to mark up to 1500 largemouth bass (or 500/agency). A maximum of 50 bass per quadrant will be tagged. Six quadrants can be sampled per day with 1200 seconds (unpublished data, Virginia Department of Game and Inland Fisheries), resulting in approximately 4 days of surveys. While the target may not be achieved, significant effort will be made to mark as many of the 1500 stock size or greater fish as possible because marking between 20 and 40% of the population can significantly reduce error in population size estimates (Edwards et al. 1997).

Jurisdictions will post signs and issue press releases to inform the general public about the project to help increase reporting rates. Anglers who report catching a largemouth bass may be

entered into an annual lottery for a prize. Tags will be reported by anglers fishing throughout the year to 1-804-367-2925 (maintained by Virginia Department of Game and Inland Fisheries). Tags may also be reported on-line during freshwater surveys or during bass tournaments. Anglers who report capturing a marked largemouth bass will report the tag number, date of capture, size of fish, and other details of interest. Data will be entered to spreadsheets by Virginia Department of Game and Inland Fisheries.

Table 1. Projected tentative time table of actions by month for agencies to achieve objectives of proposal (2020 – 2039).

YEAR	MONTH	ACTION(S)	AGENCY
2020	MAR – APR	Agency tagging	DC DDOE, MD DNR, VA DGIF
2020	APR – MAY	Enter agency tagged bass information	DC DDOE, MD DNR, VA DGIF
2020	APR – OCT	Angler tag reporting data collection	VA DGIF
2020	APR – OCT	Tournament creel survey	MD DNR
2020	NOV – DEC	Random drawing for reporting	MD DNR
2021	APR – OCT	Angler tag reporting data collection	VA DGIF
2021	APR – OCT	Tournament creel survey	MD DNR
2021	APR – SEP	Recreational creel survey	VA DGIF
2022	NOV – DEC	Random drawing for winner of reports	MD DNR
2022	APR – SEP	Recreational creel survey	MD DNR
2022	NOV – DEC	Data analysis – tag report data	MD DNR
2022	NOV – DEC	Data analysis – recreational creel data	VA DGIF
2022	NOV – DEC	Data analysis – tournament creel data	MD DNR
2023	FEB – MAR	JOINT ASSESSMENT due to PRFC, public	DC DDOE, MD DNR, VA DGIF
2024	MAR – APR	Agency tagging	DC DDOE, MD DNR, VA DGIF
2024	APR – MAY	Enter agency tagged bass information	DC DDOE, MD DNR, VA DGIF
2024	APR – OCT	Angler tag reporting data collection	VA DGIF
2024	APR – OCT	Tournament creel survey	MD DNR
2024	NOV – DEC	Random drawing for reporting	MD DNR
2025	APR – OCT	Angler tag reporting data collection	VA DGIF
2025	APR – OCT	Tournament creel survey	MD DNR
2025	APR – SEP	Recreational creel survey	MD DNR
2025	NOV – DEC	Random drawing for winner of reports	MD DNR
2026	APR – SEP	Recreational creel survey	VA DGIF
2026	NOV – DEC	Data analysis – tag report data	MD DNR
2026	NOV – DEC	Data analysis – recreational creel data	VA DGIF
2026	NOV – DEC	Data analysis – tournament creel data	MD DNR
2027	FEB – MAR	JOINT ASSESSMENT due to PRFC, public	DC DDOE, MD DNR, VA DGIF

Assumptions

This mark-recapture project makes some basic assumptions. The first assumption is that the population is geographically closed, with no immigration or emigration, and demographically closed, with no births or deaths. Quadrants for sampling largemouth bass are spread throughout most of the habitable and fishable area for largemouth bass. It is possible that individuals will emigrate beyond areas of this survey, particularly upstream of Washington, D.C. Because the sampling unit of the project will be confined to a fishing year, births during the spring are unlikely to affect the number of caught largemouth bass later that year. However, a small percentage of largemouth bass will die from catch-and-release and harvest fishing (Love 2019).

The second assumption is that tags are not lost or missed. Tags will be shed or lost during the project. Estimates of tag shedding have been estimated as 10% within 6 months (unpublished data, Maryland Department of Natural Resources), but may be higher (14.8% within the first year and 30.3% by the second year; Meyer and Schill 2014). Tags will be missed and reporting rates will not be 100%. Outreach will be aimed at achieving the highest reporting rate possible without offering cash incentives for reporting each tag. Reporting rates will be estimated during bass tournaments, though these rates themselves may be biased because anglers fishing tournaments represent only a fractional type of anglers fishing for black bass.

A third assumption is that tagging does not change behavior of fish or vulnerability to capture. The researchers are not aware of any studies indicating that marking a fish using methods here will cause the fish to behave differently than an unmarked fish.

Our final assumptions are that tagged fish will mix at random with unmarked fish and that all fish will have an equal probability of capture that does not change over time. All fish will be tagged within a short period of time (within 4 weeks), relative to the fishing year, so it is expected that marked fish will randomly distribute themselves among unmarked fish within and/or among quadrants. Capture probabilities will not be the same among fish (e.g., probabilities for males defending a nest could differ from females) and capture probabilities will not remain the same over time because seasons (e.g., changes in water temperature or growth of submerged vegetation) will affect capture probabilities through the year.

Analysis

Abundance of largemouth bass will be estimated using two methods. First, Schnabel's (1938) modification of Peterson's population estimator (Equation 1) will be used to estimate abundance. Abundance for stock size or greater bass will be estimated using an angler intercept creel survey and mark-recapture data. Abundance for quality and preferred sized bass will be estimated using tournament creel surveys and mark-recapture data. Abundance estimates for both will be biased by differences in catchabilities. To help address bias in catchabilities, recapture data can be partitioned by season or day (e.g., tournament day). The

number of tagged fish in the population (Mt) will be multiplied by the number of fish caught during a creel survey (see below) within the time period (Ct). The sum of the products will be divided by the number of tagged fish reported (Rt), summed across time periods, and then added to 1.

Equation 1. $$N = \frac{\sum CtMt}{\sum Rt+1}$$

The addition of 1 to the denominator in Equation 1 is a modification to address tagging a small proportion of the population and improves accuracy of the population estimate. Assuming a surveyed area of 32.6% of the possible area (i.e., 60/184 quadrants) and a 40% reporting rate, preliminary modeling with Chapman's modification of Peterson's model indicated that 24.5% of the population could be tagged (assuming random distribution within quadrants) and estimated population size of stock size or greater bass would be statistically similar but 18% less than the true value (unpublished data, JWL).

Variance in the population estimate will be computed as,

Equation 2. $$Variance\left(\frac{1}{N}\right) = \frac{\sum Rt}{\sum (CtMt)^2}$$

and confidence intervals from Equation 2 will be computed assuming an alpha level of 0.05.

To determine Ct for estimating abundance of stock size or greater bass, routine angler-intercept creel surveys will be used (April – September). The angler-intercept survey will include a question related to the length of the largemouth bass to ensure that the fish was at least stock size (200 mm). It will follow the same format used by Virginia Department of Game and Inland Fisheries during prior creel surveys.

To determine Ct for estimating abundance of quality (≥ 305 mm in total length, most months) or preferred (≥ 381 mm in total length, March 1 – June 15) sized largemouth bass, a creel survey during bass tournaments held at Maryland weigh-in areas will be conducted. While Mt will remain the same for abundances estimated for stock size and quality or preferred sized bass, Ct and Rt will differ. The Ct will be estimated from a Maryland Department of Natural Resources' creel survey that yields the number of quality or preferred caught during tournaments. During this specialized fishing, anglers are incentivized to weigh the largest fish they catch, which has helped in estimating abundance of trophy sized bass (Hall et al. 2019). The Rt can be determined during a tournament when a clerk can inspect largemouth bass for tags, which will both help determine reporting rate as well as the number of recaptures during a tournament. Abundance of quality sized bass and preferred size bass will be estimated by: 1) determining number of largemouth bass that were marked when at least 305 mm or 381 mm in total length; 2) determining the number of largemouth bass caught of quality size (most of year) or preferred size (March 1 – June 15) during bass tournaments; and 3) determining the number of recaptured quality and preferred sized largemouth bass caught during bass tournaments.

A second method for estimating stock size or greater abundance will be accomplished with sufficient reporting data that illustrate each fishs' monthly capture history (January – December). Because capture probabilities likely differ among individuals and over time, this method will allow for heterogeneity in capture probabilities when deriving abundance. Heterogeneity in capture probability will be modeled using the Closed Captures Huggin's Heterogeneity model to fit three parameters: probability of capture (p), probability of recapture (c), and probability of a mixture distribution applied to capture probabilities. This model allows for heterogeneity among capture and recapture probabilities as a function of the mixture distribution. The model likelihood will be used to derive abundance. To help estimate an appropriate likelihood for this complex model of heterogeneity, an annealing algorithm will be used to avoid estimating abundance from local maxima and instead, to estimate it from a global maximum. We will also use a logit-link function to fit data to the identity matrix and determine the best model by comparing Akaike's information criterion (AIC) values using the program MARK. The models will differ based upon the number of mixture distributions used, which in turn affect the level of heterogeneity in the capture probabilities.

Ancillary Information

When the data are sufficient, we may use mark-recapture information to also estimate mortality rates using length-converted catch curves (Pauly 1990) or Jolly-Seber models that include parameters for age-specific instantaneous mortality rates (Jiang et al. 2007). Mortality rates are commonly measured using catch-curve analysis, but can also be derived from mark-recapture data by using length-converted catch curves (Pauly 1990; Leaf et al. 2007). Reported length from anglers can be used to generate length-frequency distributions that can then be analyzed to estimate total mortality rate.

Joint Assessment

Abundances of stock size or greater, quality sized, and preferred sized largemouth bass will be reported over time to examine trends. Total abundance should be positively correlated with standardized catch (catch per hour) that will be averaged across surveyed quadrants. Catch rates from recreational anglers and tournament anglers from creel surveys will also be reported across years. The routine three-year assessment of catch and catch rates will form the basis of a routine cooperative report authored by each of the jurisdictions (Table 2).

Table 2. Tentative actions for recurring years for specified agencies between 2020 and 2039.

RECURRING YEARS	NOTABLE ACTIONS	AGENCY
2020, 2024, 2028, 2032, 2036…	Agency Tagging	DC DDOE, MD DNR, VA DGIF
2021, 2026, 2031, 2036…	Recreational Creel Survey	VA DGIF
2022, 2025, 2029, 2034, 2038…	Recreational Creel Survey	MD DNR
2023, 2027, 2031, 2035, 2039…	Joint Assessment Due	DC DDOE, MD DNR, VA DGIF

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Figure 1. Distribution of all possible 1 km^2 quadrants of Potomac River, with color shading indicating the jurisdiction that would be responsible for surveys (Maryland = blue; Virginia = green; D.C. = red).